Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

to Kirchhoff's ideal, and it will ultimately dispense with that intricate scaffolding which entwines the edifice of recent physics. It is an ascending process of abstraction merely, in which the unessential is inevitably eliminated.

* * *

Of the mechanics proper of the volume, we may say that Professor Boltzmann has sought to reinstate the science in its old form, as opposed to the newly-promulgated reconstructions, which have given it an entirely foreign dress. At the same time, his aim is to profit by the new criticisms and to avoid the old obscurities,—to free the old system of its defects while not destroying its familiarity. The work is complementary to his *Gastheorie*, which is not yet completed. The present volume is the first part; the second part will treat more particularly of the principles required in the *Gastheorie*. T. J. McCormack.

Des Méthodes dans les Sciences de Raisonnement. Par *J. M. C. Duhamel*, Membre de l'Institut, etc., etc. Five Vols. in 8vo. Paris: Gauthier-Villars, 55 Quai des Grands-Augustins. Price, for the entire work, 27 fr. 50 c. (Also sold singly.)

The present work is divided into five parts. It is not new, having first been published in the period from 1866 to 1872. It is a classical production in the philosophy of the exact sciences, but as it has not had the vogue in America or in England which from its general excellence and originality it deserves, and as its various parts have run through several editions, some of which are quite recent, we hold ourselves justified in giving a general characterisation of its objects and contents.

M. Duhamel was born in 1797, and died in 1872. He held relatively high rank as a mathematician, but his chief fame rests upon his successful activity as an educator, as an author of high class mathematical text-books, and as a shaper of methods of instruction. He was educated at the École Polytechnique, and was associated with the same institution as professor for more than thirty years. The idea of the present work on the philosophy of the exact sciences took its origin when he was a student engaged with the classical difficulties that, from the inception of philosophy, have ever disquieted the thinking mind. The career of instruction which he subsequently adopted involved, to his conscientious feeling, the obligation of removing these difficulties. It was not in his nature to affirm the exactitude of things concerning which he was himself in doubt; neither could he be content with possessing the conviction of that exactitude while unable to impart it to his pupils. His inward sense revolted against the counsel of D'Alembert, "Keep on, and faith will come to you." The imperative duty of his new calling, therefore, was, first, to remove the difficulties for himself, and, secondly, to give a clear and rigorous elucidation of them for the benefit of his pupils.

Such was the origin of the great work before us. It is the achievement of a mathematically trained mind, and exhibits the usual excellencies and shortcomings of this type of thinking. It is also a characteristic production of French thought, preserving the main traditions of the philosophy and psychology of Descartes, and of the deistic theology of the eighteenth century.

In studying the general questions presented by the development of the mathematical sciences, M. Duhamel was naturally led to study the same methods as embodied in the various other rational sciences, whatever their nature and scope. His original task was thus broadened into a study of pure logic in its entirety, to which he restricted himself, quite to the exclusion of psychology. The first part of his work treats of the methods of reasoning to be pursued in the resolution of problems presenting themselves in any science in which research starts from ideas that are admitted as self-evident, and from principles that are regarded as certain. His logic differs from the syllogistic logic of Aristotle as improved by Euler; for he believes it to be a contravention of reason to seek the necessary and sufficient criteria for determining the correctness or falsity of deductive thought, when it is known that the reasoning necessary to establish these criteria must be conducted without their assistance,—all of which can by hypothesis lead only to uncertain results. The correctness of a deduction is recognised by its evidence, and Descartes, in subjecting all knowledge to the touch-stone of this feeling or sentiment of evidence, rejected all the precepts of logic, as unfit guides in the search for truth. Such was the opinion, also, of the author of the famous Port Royal Logic, who, while admitting the uselessness of the syllogistic rules for deduction, recommended them as an exercise for the mind. It is strange, M. Duhamel thinks, that Aristotle, intellectual giant that he was, should not have considered the analytical method which has been attributed to his master, Plato,—a method in which M. Duhamel discovers the key to the logic of science, and which is applicable not only to mathematics but to all sciences in which reasoning from necessary and sufficient data is involved. The logic of Aristotle was occupied exclusively with defining the precautions which were necessary to avoid incorrect conclusions, which in practice there is scarcely any danger of drawing, instead of detailing methods according to which the deductions should be conducted in order to demonstrate a doubtful proposition or to solve some given problem.

We shall now give a few brief indications of the method and type of thought which M. Duhamel himself pursues. The state of certainty is produced in man by the vivid sentiment of truth, that is, by evidence. But this evidence is not infallible; it must be admitted with extreme reserve. There are truths, however, the evidence of which strike all minds immediately, and which must be admitted as points of departure; and the object of methods of reasoning is by the assistance of these truths to establish others which will produce in men the same sentiments of evidence. Higher beings would have no need of such methods, but would see the truth directly by the same evidence with which we saw the initial truths. To such beings our methods would be unnecessary; they are made only to supplement the weakness of the human mind.

The necessary relations derived from the nature of certain things are the laws of those things. The definition of a thing is the statement of the relations connecting it with known things. The operation of the mind by which we arrive at the knowledge of an unknown relation from other known relations is called deduction, or reasoning. The deduction is effected by the sentiment of evidence, which has need of no rule, and can be supplanted by none. The syllogism is a mere tautology; it merely tells us that when we have discovered that a certain property belongs to some individual thing, we have the right to assert that it belongs to that individual thing. The errors committed in reasoning spring far less frequently from mistakes of deduction than from the incorrectness of the initial propositions. The place where the error is most likely to arise is in the establishment of the general propositions of science, and in the act of determining whether given individual things are really comprised in those propositions. When a proposition has risen to the stage of an axiom, it exhibits all the guarantee that one can hope for, inasmuch as it has the sanction of all mankind at all times; it must be believed in, or we must renounce the usage of our intelligence; it is one of those beliefs that have been inspired in man by the author of his existence, and by which man has never been lead into error. Besides these primary propositions, there are less certain truths which are called axioms of the second order, and an additional class of propositions which are designated conjectural, such as our belief in the existence of matter, the belief in the determinateness of things, and so forth, and so forth.

In the entire first volume we detect the distinguishing marks of the scientific philosophy of the middle of this century: the repudiation of metaphysics, the substitution therefor of an equally fragile philosophical foundation, a certain independence of religious dogma, but in place of the latter, a hereditary dependence on the central principle of the deistic philosophy. The general test of truth is *evidence*, which has an entirely subjective, but no objective, criterion, unless it be the old theological criterion of Descartes, that God can never have willed to deceive his creatures.

The foundations past, the reasoning is more solid, In the remainder of the first part of the work we have a very fine discussion of the principles of formal logic, the methods of deductive procedure in science, of the methods of analysis and synthesis, and many luminous remarks upon the history of scientific logic with Plato, Aristotle, Euclid, Pappus, Descartes, Bacon, Arnaud, Condillac, and the rest. Incompatible and contradictory propositions are defined; the possibility of drawing correct conclusions from false premises is clearly discussed; the nature of the rational sciences is analysed, and their classification for the purpose in hand briefly indicated; the various methods for demonstrating the correctness or falsity of propositions is given; and so on.

The greatest stress is laid by the author on his enunciation of a new form of the ancient method of mathematical analysis, which he has perfected, extended, and made more precise. The method of analysis as defined by Euclid regards a proposition as demonstrated when the inquirer has deduced from that proposition as a necessary consequence some other proposition which is already recognised as true; but the statement of the method is faulty, for it is well known that true propositions can be correctly deduced from false propositions. The exposition of the ancient method of analysis as given by Pappus is the same as that of Euclid, but in this exposition a check is placed upon the reasoning in that it is required that the analytical demonstration shall be reversed, and the chain of ratiocination conducted backward synthetically from the result reached by analysis, to the original proposition. The method of analysis which M. Duhamel proposes, and which is necessarily followed in every case where rigorous demonstration is effected, avoids the reversion of the process, and renders the analytical procedure alone sufficient. But the analytical procedure of M. Duhamel is rather a procedure of discovery; it requires the investigator to search for some proposition of which the original proposition is a necessary consequence; and then again to search for some other proposition of which the one which was first sought is a necessary consequence; and so on, until a final proposition is reached of which the proposition next to the last is a necessary consequence. It is a method for *seeking* and not necessarily a method for *finding*. And we may add that the reversion of procedure which is regarded as the defect of the method of Pappus is not really avoided, but is effected step by step and coincidently with the analysis. It is to be observed, further, that the reversion is necessary, for unless the successive propositions are reciprocal the deduction could not proceed from the proposition to be established to that which was sought and which is known to be true. So much for *propositions*. The procedure for the solution of problems is analogous, but more varied.

Having thus in the first part of his work expounded what a rational science denotes, how it takes its being, of what nature are its problems, and what the methods are that guide the mind in its search for their solution, M. Duhamel has proceeded in the second and third parts of his work to apply these general considerations to the most perfect of all the sciences, namely, to the science of numbers and to the science of space. He considers these branches of knowledge as to their mode of origination, establishes their primary data,—that is to say, the data which are necessary and sufficient for determining the nature of their subject-matter,—and then proceeds to their development, not in all their details as expounded in special treatises, but in a perfectly general manner, so as to reveal the concatenation of the ideas in each of these branches, their most natural order of presentation, and the spirit of the various theories in which they have been embodied. Although commencing with the beginnings of mathematics, these sections are not intended for beginners; they involve a philosophy of arithmetic, algebra, analysis, and geometry which will appeal more particularly to instructors and to advanced students. But it must be remarked here that, so far as the subject matter allows, the very simplest illustrations have been selected. Only where complications themselves involve difficulties of principle are they attacked.

In the fourth part of the work, M. Duhamel has applied the general considerations developed in the first part to mechanics or the "science of forces." Technically this is one of the most important parts of the work.

In the fifth part, which is a very brief posthumous publication, he has attacked the problems of ethics, sociology, and theology. He had intended this section to be the final application of the principles so finely expounded in the work proper. "The scientific spirit," he said, "is the only legitimate guide in the study of any subject in which the elements exhibit relations which admit of the employment of reasoning." The scientific spirit, in this same sense, is made his only guide in his excursions into the realm of sentiment and of faith. It is distinctly the weakest part of the whole work, and offers a fine specimen of the very type of research which he sought to undermine by his investigations on the methods of science. Objection cannot be made so much to his reasoning as to the premises from which his reasoning starts; and such premises, as all know, are largely a matter of heredity, constitution, personal experience, and habit. But it seems impossible that a man who was a contemporary of Darwin, Strauss, and Renan could have uttered opinions like those here given on the origin of life and the system of divine providence. Of the discoveries of modern research in the domains of biology, ethnology, anthropology, and sociology, there is no trace or appreciation. Of the nobility of character, purity of sentiment, and high ideality which pervade this part of the work, there can be no question whatever; but when we look back upon the fine achievements in the theory of knowledge, in logic, mathematics, and mechanics, and formal philosophy generally, which the preceding parts exhibit, it is impossible to conceive that this last part was elaborated by the same mind. Nevertheless, from the point of view of the deistic theology itself, the development must be regarded as a considerable advance upon the old position.

This fifth part is in no sense an integral portion of the work, and is entirely in the nature of an appendix; it can be neglected. Each other part is complete in itself and obtainable by itself. And many will find here the elucidation they seek on all the subjects enumerated.

T. J. McCormack.

Grundriss einer Geschichte der Naturwissenschaften. Zugleich eine Einführung in das Studium der grundlegenden naturwissenschaftlichen Litteratur. Von *Dr. Friedrich Dannemann*, Direktor der Realschule zu Barmen. II. Band: Die Entwicklung der Naturwissenschaften. Mit 76 Abbildungen, zum grössten Teil in Wiedergabe nach den Originalwerken und einer Spektraltafel. Leipzig: Verlag von Wilhelm Engelmann. 1898. Pp., 435. Price, M. 10.50, bound.

Dr. Friedrich Dannemann has just published the second volume of his *History of the Natural Sciences*, which was begun in 1896. Volume I. consisted of a series of extracts from the works of the great natural philosophers and scientific inquirers of all ages, and aimed to give in each case a specimen of the spirit and power which